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87-06

**SPAN: ASTRONOMY AND ASTROPHYSICS**

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**JANUARY 1987**

**NSSDC TECHNICAL REPORT**

**NASA**

National Aeronautics and  
Space Administration

**Goddard Space Flight Center**

**DRAFT**

(NASA-TM-107940) SPAN: ASTRONOMY AND  
ASTROPHYSICS (NASA) 12 p

N92-28185

Unclas  
G3/90 0106520



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## I. INTRODUCTION

The Space Physics Analysis Network (SPAN) is a multi-mission, correlative data comparison network which links science research and data analysis computers in the United States, Canada and Europe. It provides a common working environment for sharing computer resources, sharing computer peripherals, solving proprietary problems, and providing the potential for significant time and cost savings for correlative data analysis.

SPAN was designed in 1980 as a computer-to-computer communication system, became operational in 1981 with three nodes and has grown very rapidly since that time. It was originally configured as a modified star with nearly all of the communications lines radiating from the Marshall Space Flight Center (MSFC). Since the very beginning, technical direction and operational support have been provided by the Data Systems Users Working Group or DSUWG (see Baker et al., 1987). The National Space Science Data Center (NSSDC) has the responsibility for managing SPAN.

In order to increase performance and reliability and to support the rapid increase of remote nodes, SPAN was reconfigured in 1986 to take advantage of a major cross center communication highway. This new topology provides 56 Kbps backbone circuits connecting four routing centers (located at MSFC, GSFC, JPL and JSC) with the remote nodes, based on geographical location, connected to the Routing Centers as 9.6 Kbps tail circuits. The "mesh" configuration, which provides multiple paths to the nodes, has significantly increased the reliability of SPAN.

As indicated by the original name, SPAN initially linked space plasma physicists working on NASA programs. However, since that time, nodes have been added which support the planetary, astronomy and astrophysics, atmospheric, land, climate and oceans communities.

SPAN now provides a communication link within the astrophysics community which facilitates scientists' ability to do NASA research by providing timely access to astronomical data and to their colleagues. With the expected upcoming NASA programs, astrophysicists will soon have at their disposal four major great observatories which will be placed in orbit above the filtering atmosphere. These observatories include: the Gamma Ray Observatory (GRO) which will explore the most energetic part of the spectrum across much greater wavelengths; the Advanced X-ray Astrophysics Facility (AXAF) that will cover the X-ray portion of the spectrum with a hundred-fold improvement in sensitivity; the Hubble Space Telescope (HST) which will penetrate deeply into the universe in visible and ultraviolet light, expanding the volume of observable space several hundred times; and the Space Infrared Telescope Facility (SIRTF) which will span the infrared part

of the spectrum with a thousand-fold increase in sensitivity. Much astrophysics research in the new era will require the use of correlative data from many different sources, an excellent application for SPAN.

This is one of a series of discipline-specific SPAN documents intended to complement the documents "Introduction to SPAN" (Green et al., 1987b) and "The Management of SPAN" (Green et al., 1987a). The purpose of this document is to provide Astronomy and Astrophysics scientists, currently reachable on SPAN, with basic information and contacts for access to correlative data bases, star catalogs, and other astrophysic facilities accessible over SPAN.

## II. ASTROPHYSICS USE OF SPAN

SPAN Astronomy and Astrophysics nodes are distributed all across the U.S. and in Europe. Figure 1 shows the SPAN reachable astrophysics and astronomy nodes. A comprehensive list of the astronomy and astrophysics nodes and contact persons is provided in the document "Space Physics Analysis Network Node Directory (The Yellow Pages)" by Ha et al., 1987.

The mission-independent nature of SPAN makes it a very effective resource for supporting many diverse scientific activities. This has been very vividly demonstrated by SPAN's support for the International Cometary Explorer (ICE) and Giotto encounters with comets Giacobini-Zinner and Halley, respectively.

### ICE Encounter

ICE's encounter with the comet Giacobini-Zinner provided the first spectacular demonstration of SPAN's capability in providing near real-time support (Green and King, 1986 and Sanderson et al., 1986). Since NASA had no plans for a spacecraft encounter with Comet Halley, the availability of Comet Giacobini-Zinner on September 11, 1985 provided the opportunity for NASA to be the first to have a spacecraft encounter with a comet. SPAN provided the communications infrastructure necessary to tie together the Principal Investigators at GSFC and the analysts and computer resources at their remote computer facilities for the purpose of communications, remote data manipulations and data analysis. The timely transfer of data (which included large numbers of plot data) between GSFC and the remote facilities (some located in Europe) allowed the ICE researchers to give preliminary results with graphics output to the press shortly after the encounter.

### Giotto's Encounter with Comet Halley

SPAN played a lesser but still very important role in supporting Giotto's encounter with Comet Halley (see Rees et al., 1986). Additional information was needed to supplement that taken by Giotto in order to determine the mode in which the Giotto instruments should be during the fly-by. SPAN was used to transfer ground based images of Halley taken at the Table Mountain Observatory (TMO) in California to Europe during the encounter. The TMO images of Halley taken before and after the closest Giotto encounter provided valuable background information (i.e., a wide angle view of the encounter) for a range of cometary processes.

# DECNET SUPPORT FOR ASTROPHYSICS

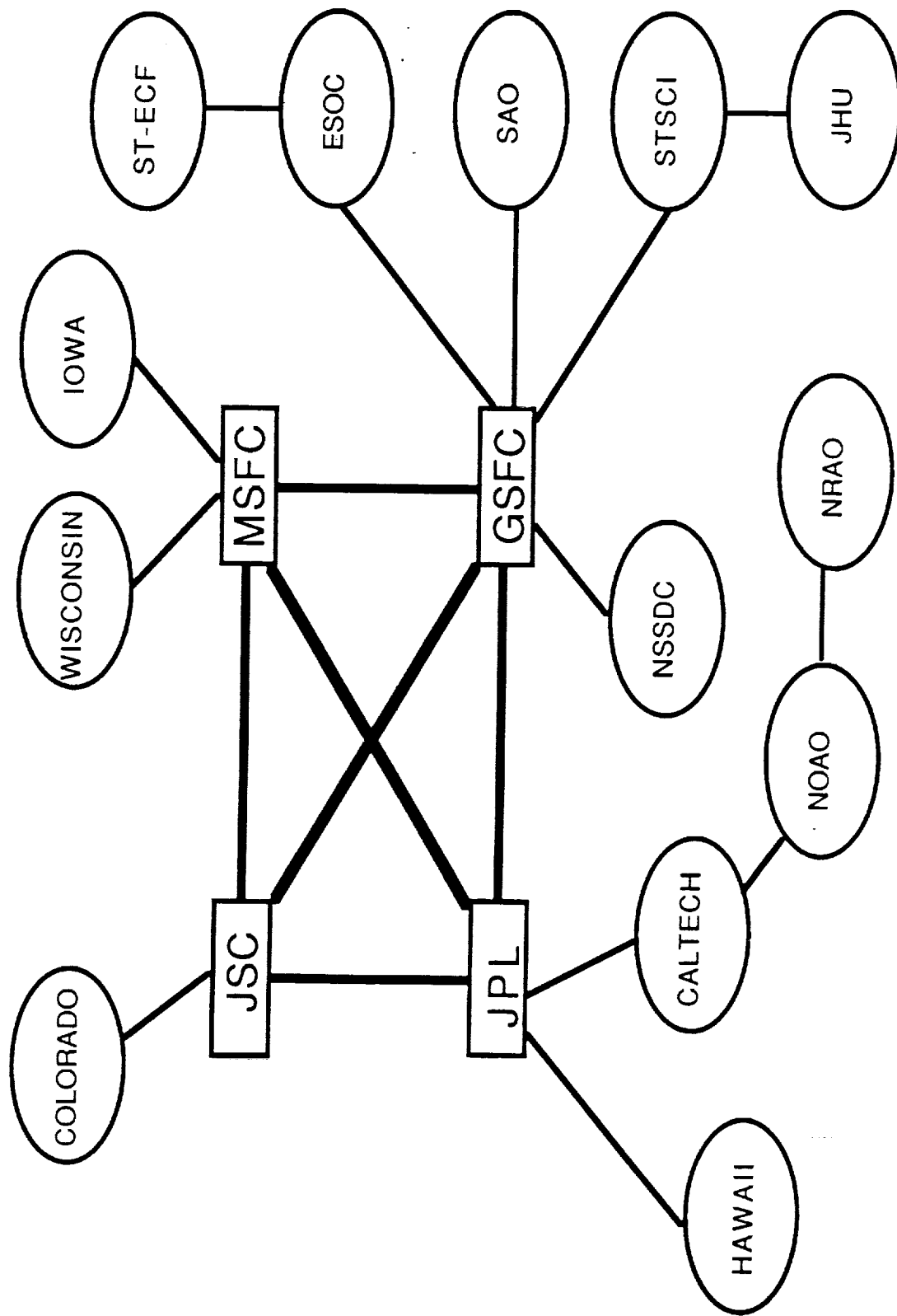


FIGURE 1

### III. SPECIAL ASTRONOMY AND ASTROPHYSICS SPAN NODES

Several of the astronomy and astrophysics nodes on SPAN are considered special because they provide access to computer resources, other facilities, or data that is of major scientific importance. These nodes are listed below along with the resources that they offer.

#### National Space Science Data Center (NSSDC)

The NSSDC has the responsibility for the dissemination of data and catalogs to any individual or organization resident in the United States. For scientists who reside outside of the U.S., the data are provided through NSSDC's World Data Center A for Rockets and Satellites (WDCA).

Requests for data catalogs and data can be handled via SPAN in several ways. If the requestor knows exactly what he or she needs then simply send a mail message to the request account (NSSDCA::REQUEST or NSSDC::REQUEST). Another way is by logging onto the NSSDC computer (\$set host NSSDC and USERNAME NSSDC). Upon logging on, the requestor will be prompted for additional information. When the main menu appears, the requestor must select item 5 to request the data or information. This procedure will also generate a mail message to the request account.

Normally charges are waived for modest quantities of data and when they are requested by an individual affiliated with: NASA installations; NASA contractors or NASA grantees; other U.S. Government agencies, their contractors or grantees; universities and colleges; state and local Governments; and non-profit organizations. When immoderate requests are made, one may expect to be charged for reproduction and processing services, in which case a requestor will be notified in advance and payment must be received prior to processing.

The NSSDC manages the Astronomical Data Center (ADC) which is a cooperative effort and operated jointly with the Laboratory for Astronomy and Solar Physics at GSFC. The ADC maintains catalogs and special data sets that are critically analyzed, improved and fully documented. Machine-readable astronomical catalogs are acquired directly from the scientific community and exchanged with other members of the international network of ADCs, primarily the central data center in Strasbourg, France. These catalogs consist of both space- and ground-based data which support space missions and basic scientific research. Catalogs are examined, analyzed, restructured and reformatted to conform to standard practices, documented, and redistributed upon request. Activities of the ADC are published in the Astronomical Data Center Bulletin, which appears periodically as enough material is available to comprise an issue.

The ADC maintains a list of currently available machine-readable catalogs that is distributed upon request. Procedures are now being developed for the network dissemination of catalogs; online information and documentation will become available in the near future.

In addition to the catalogs and data sets maintained by the ADC, the mainline NSSDC archives and disseminates astrophysics data from individual missions. It also maintains a data base of all the archived data. This information is not currently on-line, but will become accessible via SPAN when the Central On-Line Data Directory (CODD) becomes operational.

There is currently restricted SPAN access to the SIMBAD data bank (set of identifications, measurements and bibliography for astronomical data) that is located at the Centre de Données Astronomique de Strasbourg, France. Plans are underway to establish a gateway for general access to SIMBAD by the American astronomical community.

SIMBAD, in contrast to the many machine-readable catalogs of astronomical data available and to other data bases, is an integrated collection of more than 400 interconnected catalogs. This means that the identifications and data of all catalogs included are available online. For example, if one knows a single identifier for an object, all other identifiers can be retrieved along with the data listed in the original catalogs, as well as bibliographical references for papers in which the object is mentioned. This data and information retrieval is made possible through user-friendly software which allows access to the data bank by object identifications, positional information, and a wide variety of "sampling criteria". Although the data and information included in SIMBAD increase on a daily basis, a summary of the content of the SIMBAD data bank at this time is as follows: 600,000 stars and 100,000 nonstellar objects; 2 million identifications; 400 source catalogs; 1950-current bibliographical information which includes 500,000 references, 150,000 objects with references and 85 journals; and 200 MB online storage. There are currently more than 70 centers in 14 countries interrogating SIMBAD on a regular basis, and we expect these numbers to increase dramatically as more astronomers become aware of the data bank and learn how it can help to solve many of their data and information retrieval needs.

Further development of SIMBAD and its related software includes the incorporation of additional catalogs and their associated data into the data bank, the inclusion of software for more advanced operations, such as graphics for the plotting of star fields, and the interconnection of the data bank to other archives of astronomical data, e.g., satellite data for individual observations and possibly images. Additional details on future plans, along with historical and data content information, may be found in papers of Egret

(1983, 1986) and references cited therein. A major thrust is to make SIMBAD more widely available so that it can be accessed from most astronomical libraries and from personal terminals and computers located in astronomy departments, observatories, and individual offices of astronomers.

Space Telescope Science Institute (STScI)

After the launch of the Space Telescope , the STScI will contain the ST data archives and software and analysis tools which will be available to the astronomy and astrophysics community.

(TO BE COMPLETED)

National Radio Astronomy Observatory (NRAO)

(TO BE COMPLETED)

National Optical Astronomy Observatories (NOAO)

(TO BE COMPLETED)

University of Colorado

The University of Colorado houses the IUE Regional Data Analysis Facility which can be used by the astronomy and astrophysics community for the inter- active reduction and analysis of IUE data.

(TO BE COMPLETED)

## LIST OF ACRONYMS

ADC	- Astronomical Data Center
AXAF	- Advanced X-Ray Astrophysics Facility
CODD	- Central Online Data Directory
DEC	- Digital Equipment Corporation
DECnet	- DEC networking products generic family name
DSUWG	- Data System Users Working Group
GRO	- Gamma Ray Observatory
GSFC	- Goddard Space Flight Center
HST	- Hubble Space Telescope
INFNET	- Istituto Nazionale Fisica Nucleare Network
IUE	- International Ultra-Violet Observer
JANET	- Joint Academic Network (in United Kingdom)
JPL	- Jet Propulsion Laboratory
JSC	- Johnson Space Center
kbps	- Kilobit per second
MB	- Mega Bytes
MSFC	- Marshall Space Flight Center
NOAO	- National Optical Astronomy Observatories
NRAO	- National Radio Astronomy Observatory
NSSDC	- National Space Science Data Center (at GSFC)
SIRTF	- Space Infrared Telescope Facility
SPAN	- Space Physics Analysis Network
STSCI	- Space Telescope Science Institute
TMO	- Table Mountain Observatory
WDCA	- World Data Center A

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# ACKNOWLEDGMENT

The members of the Data Systems Users Working Group who fully support the SPAN management team providing much of their time to make the system successful are gratefully acknowledged. The authors would like to acknowledge the Information Systems Office and the Communication and Data Systems Division (especially Sandy Bates) at NASA Headquarters for their continued financial support for SPAN.